

## SHORT COMMUNICATION

### Aggregations of *Sphodros rufipes* (Araneae: Atypidae) in an urban forest

Steven B. Reichling<sup>1</sup>, Christopher Baker<sup>1</sup> and Christina Swartzell<sup>2</sup>: <sup>1</sup>Memphis Zoo, 2000 Prentiss Place, Memphis, Tennessee 38112 USA; <sup>2</sup>Pace Law School, 78 North Broadway, White Plains, New York 10603 USA.  
E-mail: sreichling@memphiszoo.org

**Abstract.** A large population of *Sphodros rufipes* (Latreille 1829) was discovered in a municipal park in Memphis, Tennessee. We examined potential stem diameter preference, frequency of web attachment to available tree species and the spatial distribution patterns of spiders and potential attachment structures. A wide range of structure diameters were utilized for web attachment. The association of pursewebs to tree taxa was independent of the frequency of tree taxa occurrence. The spacing of vegetation stems and trunks was approximately random, but spiders exhibited a nonrandom, aggregated distribution, which was more pronounced in subadults than adults. The factors influencing *S. rufipes* to occur in aggregations cannot be explained by the spatial proximity of potential attachment structures in the forest.

**Keywords:** Purseweb spider, random distribution, aggregations, density, tree preference

*Sphodros* is one of three genera that comprise the mygalomorph family Atypidae. Five species are confined to the United States (Gertsch & Platnick 1980), with *Sphodros rufipes* (Latreille 1829) being the most widespread and known from scattered locations throughout the eastern United States (Hoffman 1992). The species has been described as uncommon throughout most of its range (Hardy 2003), but occasionally may be locally abundant (Potat 1889; Morrow 1986; McKenna-Foster et al. 2011). As the widest-ranging *Sphodros* spider, *S. rufipes* is also the best studied. The seasonality of reproductive behaviors is well documented (McCook 1888; Coyle & Shear 1981; Morrow 1986), as is the timing and pattern of post-embryonic development (Coyle & Shear 1981). The architecture of the purseweb has been thoroughly described (Bishop 1950; Gertsch & Platnick 1980; Coyle & Shear 1981; Beatty 1986; Morrow 1986; Hardy 2003). However, its population biology is poorly documented, probably due to its generally sparse occurrence and cryptic webs. Previous studies have reported population densities (Potat 1889; Coyle & Shear 1981), but only one has described spatial patterns (McKenna-Foster et al. 2011).

Although authors frequently note the tree species to which *Sphodros* webs are attached, only Hardy (2003) has analyzed tree species association, reporting a higher frequency (58%) of attachment to oaks (*Quercus* spp.) and sweet gum (*Liquidambar*) and the avoidance of conifers and herbaceous vegetation. Muma (1944) stated that *S. rufipes* preferred small trees for web attachment, an observation that was supported by Coyle and Shear's (1981) data indicating a mean trunk diameter of 10.4 cm. Hardy (2003) pursued this topic and found no webs attached to trunks larger than 65 cm diameter-at-breast-height (dbh). The populations studied by McKenna-Foster et al. (2011) were unusual due to the majority of the webs being attached to grasses and other non-woody structures.

From these studies, a picture develops of a spider that typically attaches its web to the trunks of sapling or small hardwoods, within an environment that offers a wider variety of potentially suitable structures. Interesting questions then emerge. How constrained are the spiders to utilize web supports in close proximity to conspecifics, given their proclivity for specific types of attachment points which may themselves be spaced according to other environmental factors? Is the spacing of *Sphodros* webs solely a reflection of the arrangement of suitable supports? No previous study has examined these potential dynamics.

Following the fortuitous discovery of a male *S. rufipes* wandering the forest floor of a city park, subsequent surveys revealed a

surprising abundance of purseweb spiders, encouraging further study. This large population presented a unique opportunity to examine, for the first time, spatial distribution patterns of a purseweb spider population. The purpose of our study was to measure the density of *S. rufipes* in an urban forest island, characterize spatial patterns, and to consider these patterns in light of the spacing, size, and taxa of indigenous web-supporting vegetation.

The research was conducted during June–August 2009, in a 28.7 ha mature hardwood forest within Overton Park, Memphis, Tennessee, which became an isolated fragment when the urban expansion of Memphis encircled it by 1906 (Gilbert 1992). We inventoried and identified every tree  $\geq 7.62$  cm dbh within an 800 m<sup>2</sup> portion of the park after broad surveys indicated it was representative of the whole. Subsequent analysis of web attachment frequency to tree taxa was performed at the generic level because the structural characteristics encountered by the spiders, such as bark texture, and thus the biological relevance, would be distinct.

To determine the range of structure size chosen by the spiders, we measured stem diameter at 25 cm above the ground surface, from a random forest-wide sample of 186 plants and trees with one or more attached pursewebs. We chose this measurement instead of the dbh-standard of forestry science because the latter was less relevant to *Sphodros* behavior than diameter at the level where the spiders would encounter the structures and attach their webs.

To describe spatial patterns of *Sphodros*, three 12 × 12 m quadrats were established. Since we were interested in discovering how *Sphodros* position themselves in relation to nearby conspecifics and suitable web-supporting vegetation, selection of transect positions was not random. Instead, we established each transect at a location where broad surveys of the entire park identified high spider density. At each transect, we meticulously inspected the ground for all *Sphodros* webs, including the smallest juveniles, of which there were many, and we are confident that all webs were found. Each web was categorized as being occupied by an adult versus a subadult on the basis of diameter. Webs  $\geq 12$  mm were classified as adult. This criterion resulted in two discrete groups, with an obvious size gap between the adult threshold size and the largest subadult webs.

We quantified spatial distribution of *Sphodros* pursewebs using the methods of Morisita (1959). For each transect, we reiterated the calculation of Morisita's Index ( $I_s$ ) for 1, 2, 4 and 6 m<sup>2</sup> quadrants, and observed for changes in the distribution pattern. Measuring spatial pattern at multiple scales is essential because aggregations are a function of the scale at which they are viewed. For each quadrant size,

Table 1.—List of trees ( $n = 1985$ ) by genus with their relative frequency and mean dbh (cm) and the number of associated *Sphodros rufipes* webs.

Genus	DBH (SE)	Percent occurrence	Webs
<i>Acer</i>	17.8 (0.7)	10.28	9
<i>Aesculus</i>	7.6 (0.4)	0.65	0
<i>Albizia</i>	14.5 (1.7)	0.55	0
<i>Asimina</i>	10.2 (2.9)	35.11	9
<i>Betula</i>	16.1 (2.11)	0.16	0
<i>Carpinus</i>	14.4 (0.8)	1.91	5
<i>Carya</i>	18.9 (1.0)	8.87	5
<i>Cercis</i>	19.1 (3.2)	1.36	0
<i>Celtis</i>	21.3 (2.8)	1.01	0
<i>Cornus</i>	18.8 (2.3)	1.21	1
<i>Fraxinus</i>	34.5 (3.1)	2.42	1
<i>Juniperus</i>	6.0 (1.8)	0.20	1
<i>Liquidambar</i>	36.3 (2.0)	5.44	3
<i>Liriodendron</i>	65.7 (4.7)	3.73	4
<i>Morus</i>	14.0 (2.8)	0.20	0
<i>Quercus</i>	69.2 (2.7)	8.16	22
<i>Sassafras</i>	20.3 (1.6)	1.26	0
<i>Ulmus</i>	16.3 (0.4)	17.48	22
Total		100.00	82

index values  $< 1$  occur when distribution is hyperdispersed and  $> 1$  when underdispersed (Vandermeer 1990). An abrupt change in the index value between two quadrat sizes denotes the approximate area encompassed by the aggregations (Vandermeer 1990).

We identified 1,985 trees, composed of 30 species of 21 genera (*Acer negundo*, *A. rubrum*, *A. saccharum*, *Aesculus sylvatica*, *Albizia julibrissin*, *Asimina triloba*, *Betula papyrifera*, *Carpinus caroliniana*, *Carya glabra*, *C. illinoensis*, *C. tomentosa*, *Cercis canadensis*, *Celtis occidentalis*, *Cornus florida*, *Fraxinus americana*, *Liquidambar styracifolia*, *Liriodendron tulipifera*, *Morus rubra*, *Nyssa sylvatica*, *Platanus occidentalis*, *Populus deltoides*, *Prunus serotina*, *Quercus alba*, *Q. falcata*, *Q. rubra*, *Q. schumardii*, *Q. velutina*, *Sassafras albidum*, *Ulmus americana*, and *U. rubra*).

The majority (65%) of tree genera occurring in Overton Park were utilized by *S. rufipes* as purseweb supports (Table 1). A large proportion (20%) of spiders utilized small herbaceous plants as web supports, as depicted in Fig. 1. We also observed *Sphodros* utilizing miscellaneous ground litter as supports, such as fallen dead leaves and limbs (9%). A few webs (6%) were not supported by any structure; i.e., were aligned horizontally upon the forest floor, as is more characteristic of the Old World *Atypus* (Gertsch & Platnick 1980), or were partially attached to fallen debris.

The diameter of 186 vegetation stems or trunks supporting pursewebs ranged widely (0.01–268.0 cm, mean = 47.2 cm, SE = 20.5). The diameters of stems with webs containing subadults ( $n = 170$ ) did not differ significantly ( $\chi^2_1 = 0.13$ ,  $P = 0.73$ , from those supporting webs of adults ( $n = 16$ ).

The frequency of *Sphodros* webs among tree genera was significantly different ( $\chi^2_{17} = 70.4$ ,  $P < 0.0001$ ) than the distribution of tree genera within the total population in the study site. *Ulmus* and *Quercus* were the sites of attachment for the majority (54%) of adult-occupied webs. Seven tree genera were not observed to have webs attached. Among trees supporting at least one purseweb, *Cornus*, *Fraxinus*, and *Juniperus* were the least frequently utilized by spiders.

A total of 853 pursewebs were counted in the three transects. Webs occupied by adults comprised 4% of the sample ( $n = 36$ , transect range 10–14) versus subadults ( $n = 817$ , transect range 152–504). The mean density of adults was  $0.08/m^2$  and mean density of subadults was  $1.9/m^2$ .



Figure 1.—*Sphodros rufipes* web utilizing a small herbaceous sprout as support.

The spatial distribution of stems and tree trunks was approximately random in both the broad landscape and smaller transect perspective. Within the  $12\text{ m}^2$  transects,  $I_s$  ranged from 1.0–1.6 (mean = 1.2). Spatial arrangement of adult and subadult classes in the  $12\text{ m}^2$  transects indicated aggregation (Fig. 2). For adults in each transect,  $I_s$  min/max values were 1.2–2.2, 1.3–2.1, and 0.9–1.6 (calculated for 2, 4, and  $6\text{ m}^2$  quadrats only due to small sample size). For subadults, min/max of  $I_s$  were 1.0–2.0, 2.6–6.5, and 1.1–2.6.

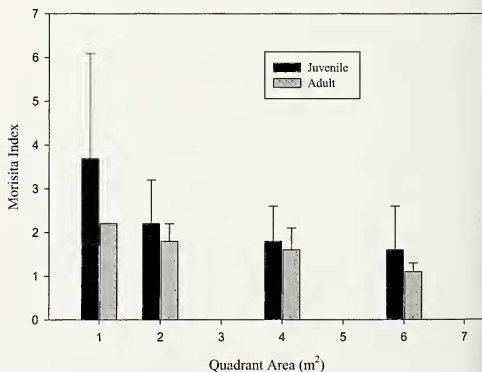


Figure 2.—Mean (+ SE) values of Morisita Index for subadult and adult subclasses of *Sphodros rufipes* at 1, 2, 4, and  $6\text{ m}^2$  quadrat size in three  $144\text{ m}^2$  quadrats. Adults in the  $1\text{ m}^2$  quadrat consisted of a single individual.

Though purseweb spiders aggregate, the available support structures are both abundant and randomly positioned. Thus, the spiders are not underdispersed as an artifact of the spatial constraints of suitable attachment sites. It is tempting to hypothesize that juvenile purseweb spiders are displaying colonial attraction to each other by their close proximity. An alternative explanation, which we favor, is that the poor dispersal capabilities of the spiderlings restrict them to settle into high-density groups, composed primarily or completely of siblings. We propose that these high densities, and the competition for prey and other limited resources that they engender, represent suboptimal conditions for the spiders, which is gradually alleviated by fitness-based mortality.

We measured a density that was ten times greater than the previously highest measure documented for the genus (Mckenna-Foster et al. 2011). In most states where it occurs, *Sphodros* is listed either as rare or as a species of concern (Anonymous 2004; Roble 2006). Commenting on the status of *S. coylei* Gertsch & Platnick 1980, Wolff (2005) speculated that *Sphodros* may require large areas of habitat to survive, that urbanization was the primary threat to the genus in most areas, and that isolated populations might not have long-term viability. Therefore it is noteworthy that in a small fragment of forested habitat, isolated for over a century and embedded within an urban landscape, *S. rufipes* is abundant.

We thank Andy Kouba, Jon Davis, Fields Falcone, Stephanie Cassel, Lauren Lieb, Cybil Covic, and Mitch Taylor for sharing tree data. Chellie Bowman assisted us in the forest surveys. Alan Jaslow and Erin Willis lent statistical guidance. The Memphis Zoological Society provided time and equipment to conduct this study.

#### LITERATURE CITED

- Anonymous. 2004. Current and historical rare, threatened, and endangered species of Calvert County, Maryland. Maryland Dept. of Natural Resources, Wildlife and Heritage Service, Annapolis, Maryland.
- Beatty, J.A. 1986. Web structure and burrow location of *Sphodros niger* (Hentz) (Araneae, Atypidae). *Journal of Arachnology* 14: 130–132.
- Bishop, S.C. 1950. The purse-web spider *Atypus abbotti* (Walckenaer) with notes on related species (Arachnidae: Atypidae). *Entomological News* 61:121–124.
- Coyle, F.A. & W.A. Shear. 1981. Observations on the natural history of *Sphodros abbotti* and *Sphodros rufipes* (Araneae, Atypidae) with evidence for a contact sex pheromone. *Journal of Arachnology* 9:317–326.
- Gertsch, W.J. & N.I. Platnick. 1980. A revision of the American spiders of the family Atypidae (Araneae, Mygalomorphae). *American Museum Novitates* 2704:1–39.
- Gilbert, D. 1992. The old forest. *Memphis Magazine* 17(7):36–41, 66–71.
- Hardy, L.M. 2003. Trees used for tube support by *Sphodros rufipes* (Latreille 1829) (Araneae, Atypidae) in northwestern Louisiana. *Journal of Arachnology* 31:437–440.
- Hoffman, R.L. 1992. Purse-web spiders (Atypidae) in Virginia (Araneidae: Mygalomorphae). *Banisteria* 1:5–7.
- McCook, H.C. 1888. Nesting habits of the American purseweb spider. *Proceedings of the Philadelphia Academy of Natural Science* 40:203–220.
- Mckenna-Foster, A., M.L. Draney & C. Beaton. 2011. An unusually dense population of *Sphodros rufipes* (Mygalomorphae: Atypidae) at the edge of its range on Tuckernuck Island, Massachusetts. *Journal of Arachnology* 39:171–173.
- Morisita, M. 1959. Measuring the dispersion of individuals and analysis of the distributional patterns. *Memoirs of the Faculty of Science, Kyushu University Series Biology* 2:215–235.
- Morrow, W. 1986. A range extension of the purseweb spider. *Journal of Arachnology* 14:119.
- Muma, M.H. 1944. A report on Maryland spiders. *American Museum Novitates* 1257:1–14.
- Poteat, W.L. 1889. A tube-building spider. *Journal of the Elisha Mitchell Scientific Society* 6:134–147.
- Roble, S.M. 2006. Natural heritage resources of Virginia: rare animals. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia.
- Vandermeer, J. 1990. *Elementary Mathematical Ecology*. Krieger Publishing Co., Malabar, Florida.
- Wolff, R.J. 2005. Coyle's purseweb spider *Sphodros coylei*. *Comprehensive Wildlife Conservation Strategy*, South Carolina Department of Natural Resources, Columbia, South Carolina.

*Manuscript received 5 May 2010, revised 30 August 2011.*